EXHIBIT A:

ENVIRONMENTAL ASSESSMENT

FOR THE

KAHAUALE'A

GEOTHERMAL PROJECT

Kahauale'a

FEBRUARY 1982

ENVIRONMENTAL ASSESSMENT
FOR THE
KAHAUALE'A GEOTHERMAL PROJECT
PUNA DISTRICT, ISLAND OF HAWAII
HAWAII

TAX MAP KEY: No. 1-1-01, Parcel 1

APPLICANT:

THE TRUSTEES OF THE ESTATE OF JAMES CAMPBELL
828 Fort St. Mall, Suite 500
Honolulu, Hawaii 96813

In Coordination With
THE TRUE/MID-PACIFIC GEOTHERMAL VENTURE

This Environmental Document is Submitted
Pursuant to Chapter 343, HRS

ACCEPTING AUTHORITY:

CHAIRMAN, BOARD OF LAND AND NATURAL RESOURCES
State of Hawaii

PREPARED BY:

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Honolulu, Hawaii 96813

FEBRUARY 1982

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Department of the Interior, Fish and Wildlife Service
Department of the Interior, National Park Service
U. S. Geological Survey

B. STATE OF HAWAII

University of Hawaii
- Hawaii Institute of Geophysics
- Hawaii Natural Energy Institute

Department of Land and Natural Resources
- Division of State Parks
- Division of Water and Land Development
- Division of Land Management
- Division of Forestry and Wildlife

Department of Planning and Economic Development

C. COUNTY OF HAWAII

Planning Department
Water Department

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A. TECHNICAL CHARACTERISTICS

1. Objectives

The State of Hawaii is almost totally dependent on imports of crude oil and petroleum products and is vulnerable to supply disruptions and price fluctuations in the global energy market. As a consequence of the high cost of imported fuel, electricity rates in Hawaii are among the highest in the nation.

Because of Hawaii's recent volcanic origin and geography, the State has no indigenous fossil fuel reserves and is isolated from systems such as coal and natural gas. Fortunately, Hawaii is rich in renewable energy resources which are becoming available under new and improved technologies. Those resources include geothermal, solar, wind, biomass, hydropower, and ocean thermal gradients.

Because of the abundance of renewable natural resources in Hawaii, the State efforts are now directed toward decreasing the dependence upon imported fuel and focusing on the development of indigenous energy sources such as geothermal energy.

In 1978, the State Legislature enacted the Hawaii State Plan, Chapter 226 of the Hawaii Revised Statutes. The purpose of the plan is to improve the State-wide planning process, which is to articulate goals, objectives, and policies intended to guide future development in Hawaii. The State Plan defines two energy objectives. The first is to provide a dependable, efficient, and economical State-wide energy system capable of supporting the current and future needs of the people of Hawaii. The second is to provide increased energy self-sufficiency by decreasing Hawaii's dependence on imported fuel.

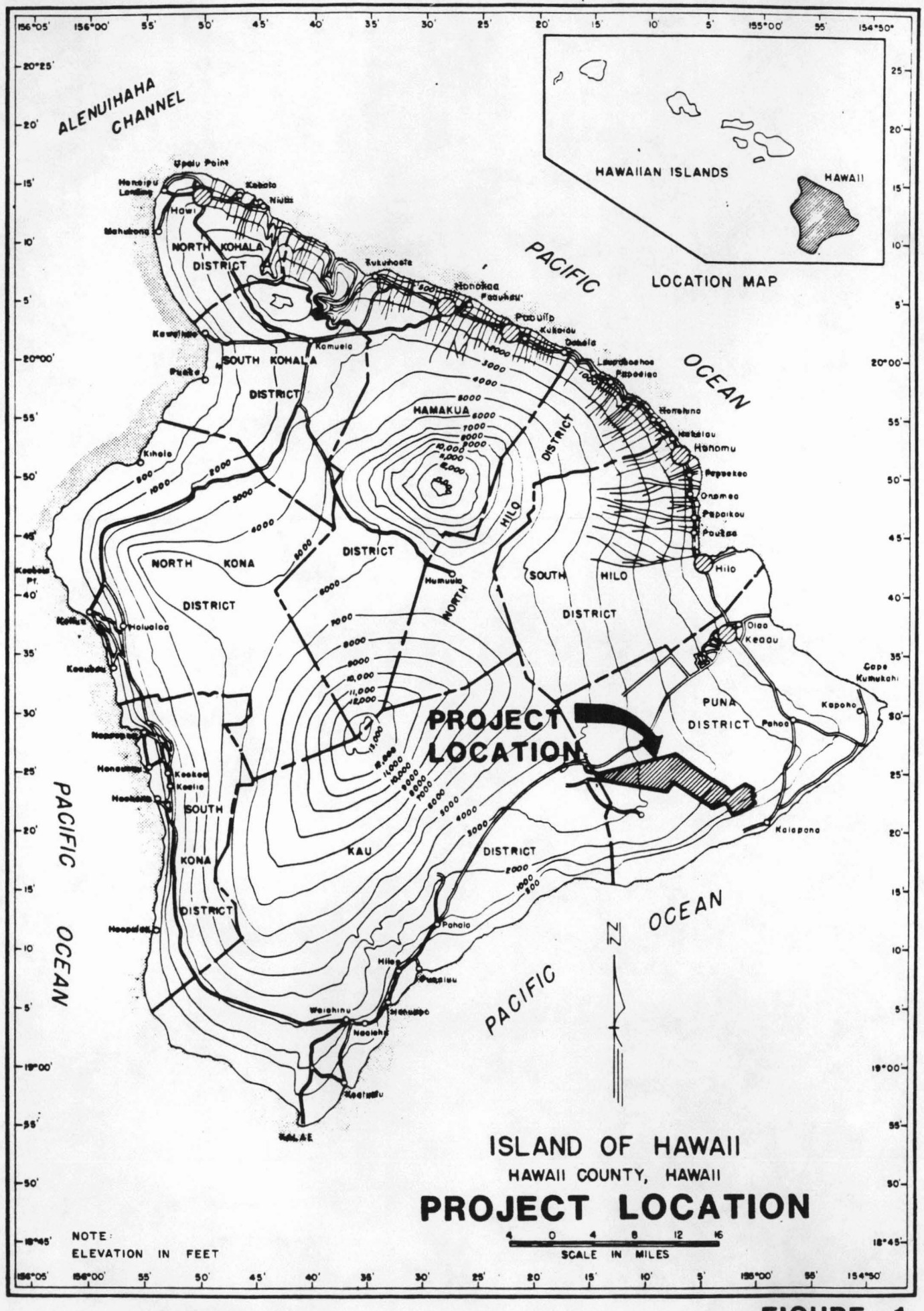
The amended General Plan of the County of Hawaii places emphasis upon energy self-sufficiency because of the excessive dependence on imported oil and the escalating cost of electricity. The County's objectives include energy self-sufficiency and the establishment of the Big Island as a demonstration community for the development and use of natural energy resources.

The objective of the proposed project is to develop the geothermal resources within Kahauale'a to generate 250 MWe as a major contribution toward achieving the above energy objectives of the State and County Plans.

2. Description

An Environmental Assessment (EA) is required in support of a Conservation District Use Application (CDUA) by The Trustees of the Estate of James Campbell, fee owner and prospective geothermal mining lessee of the land of Kahauale'a and adjacent Campbell Estate property. The proposed project is described in detail in the Project Master Plan submitted with the CDUA. This EA has been prepared for The Trustees of the Estate of James Campbell in coordination with the True/Mid-Pacific Geothermal Venture, developer and prospective sublessee of the mining lease. The Kahauale'a Geothermal Project is a joint enterprise of The Trustees of the Estate of James Campbell who have owned the property for 90 years and the True/Mid-Pacific Geothermal Venture, an experienced energy exploration and development group from Casper, Wyoming.

The project location within the Puna District of the Big Island is indicated on Figure 1. The extent of the Campbell Estate lands in the Puna District is indicated on Figure 2, together with adjacent areas. The Kahauale'a ahupua'a is adjacent to the Hawaii Volcanoes National Park and extends downslope from Volcano to the ocean shoreline by Queen's bath, near Kalapana. The Trustees of the Estate of James Campbell will submit a Geothermal Mining Lease Application to include most of the Campbell Estate lands as indicated on Figure 2. The property on which a Conservation District Use Application (CDUA) and a geothermal mining lease are requested for exploration, development and marketing of geothermal resources is the Kahauale'a parcel in



ISLAND OF HAWAII

HAWAII COUNTY, HAWAII

PROJECT LOCATION

FIGURE 1

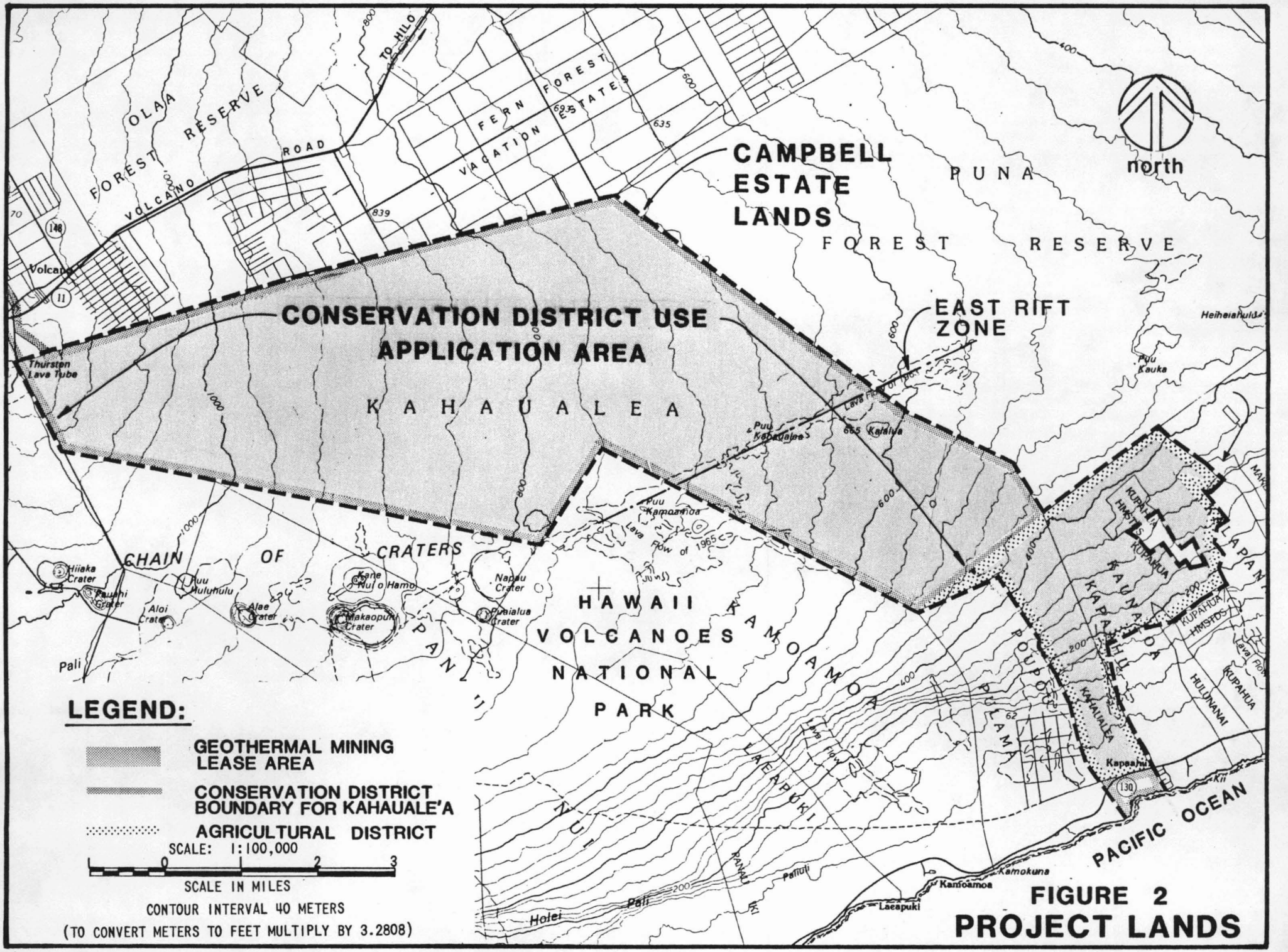


FIGURE 2
PROJECT LANDS

Puna District, Island of Hawaii. Figures 1 and 2 show the location and project area maps. The property is shown on Tax Maps as T.M.K. No. 1-1-01, Parcel 1, containing 21,943 acres more or less (Conservation District Subzone Code L), and 992 acres more or less (Agricultural District) for a total of 22,935 acres more or less and adjoining parcel T.M.K. No. 1-1-08, Parcel 1, (Agricultural District) containing 2,526 acres for a total project area of 25,461 acres more or less. However, as indicated in Figure 3, the lower portion of T.M.K. No. 1-1-01, Parcel 1, will not be explored. Both parcels are referred to hereinafter as Kahauale'a.

It has been calculated that Kahauale'a has the potential in geothermal resources capable of producing up to 250 MWe of electrical power plus an undetermined amount of hot water and steam for direct use applications. (One megawatt of electricity [MWe] equals 1,000,000 watts.) The estimates of this resource potential are the result of evaluation and assessment of extensive historical data on the geology of the area and the volcanic activity of Kilauea, geothermal exploration results here and worldwide, theory on the nature and characteristics of geothermal fluids and reservoirs, and field survey of the geology of the rift systems of Hawaii's volcanoes and in particular, the east rift of Kilauea.

The initial objectives of this project are to prove the existence of a geothermal resource, its characteristics, and whether it can be economically produced from the area of discovery and marketed. Subsequent exploration and development, in parallel with market development, will help determine the extent of the producible resource underlying Kahauale'a, the rate of development and whether the planned scope (to generate 250 MWe) of the project can be realized.

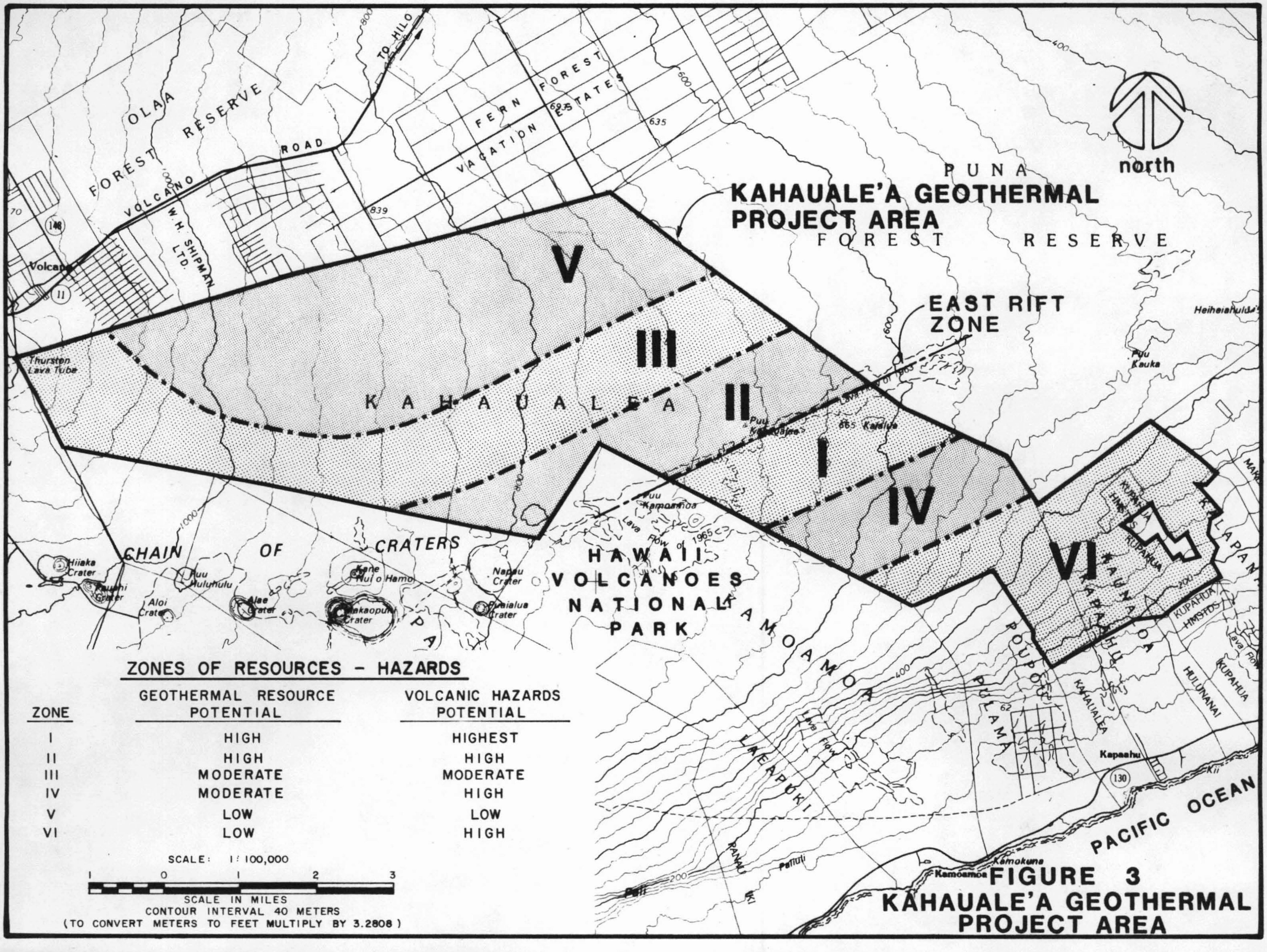
The development concept is designed to alternate exploration and development (production) drilling. Upon proving, through exploration and confirmation drilling, the existence of resources sufficient to supply an existing or contracted for demand, development drilling (i.e., drilling of "step-out" wells generally within 2,000 feet of a successful well) will be conducted until that demand is satisfied. Exploration drilling, at distances normally greater

than 2,000 feet from an existing well, would then be resumed in other areas within Kahauale'a to prove the existence of additional resources which could be economically developed.

The prospective drilling sites considered necessary to enable full development of the estimated geothermal resource potential of the Kahauale'a project area, the planned location of electrical generating plants and the planned alignments of connecting roads are as indicated in the Site Development Plan shown in Figure 4. Such planning data is subject to change after commencement of drilling operations and more data on the location, extent and quality of the resource is known. A geophysical survey with magnetic and electrical techniques will be used to precisely locate the position of the initial drilling site. The criteria for determining the prospective locations (and number) of drilling sites, plant sites and roads will be based on the following:

- estimates of geothermal resource potential (quality and quantity) underlying Kahauale'a;
- most probable areas for discovery and development in consideration of the natural risks and uncertainties attendant with geothermal exploration and development;
- potential volcanic hazards within the parcel;
- environmental impacts relative to full development of the resource potential.

The proposed exploration, development and marketing activities of 250 MWe hereinafter described as "the project" will be executed as a continuum of efforts over a 14 to 20-year period to develop the geothermal potential of the Kahauale'a project area. This continuum of efforts may be conveniently described as a series of sequential but interrelated activities involving road and site preparation, drilling operations, testing and evaluation of discovered resources, development (production) drilling operations, installation of field production equipment including pipeline transmissions



ZONES OF RESOURCES - HAZARDS

ZONE	GEOTHERMAL RESOURCE POTENTIAL	VOLCANIC HAZARDS POTENTIAL
I	HIGH	HIGHEST
II	HIGH	HIGH
III	MODERATE	MODERATE
IV	MODERATE	HIGH
V	LOW	LOW
VI	LOW	HIGH

SCALE: 1:100,000

SCALE IN MILES

CONTOUR INTERVAL 40 METERS

(TO CONVERT METERS TO FEET MULTIPLY BY 3.2808)

FIGURE 3
KAHAUALE'A GEOTHERMAL PROJECT AREA

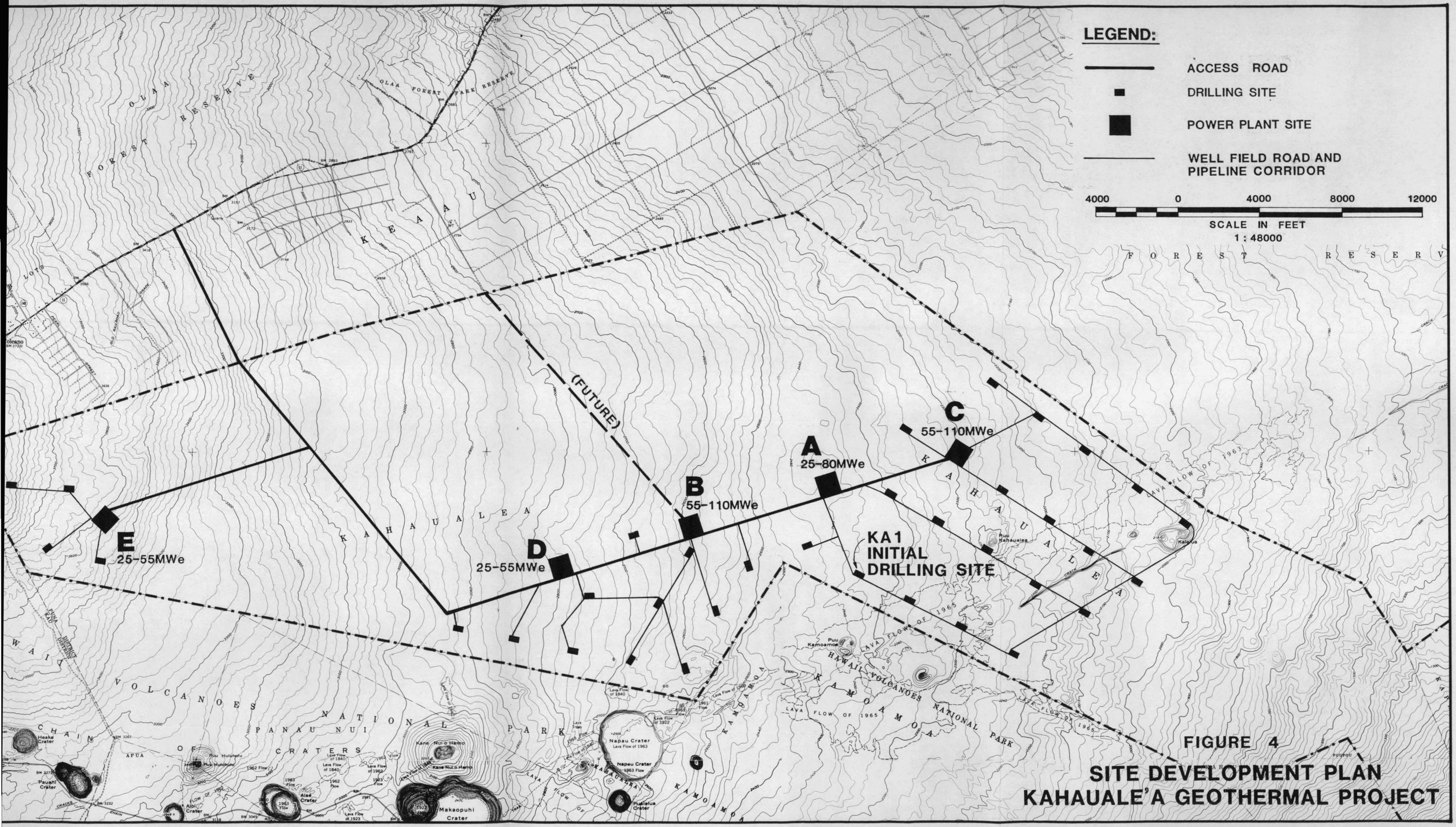


FIGURE 4

SITE DEVELOPMENT PLAN
KAHAUALE'A GEOTHERMAL PROJECT

systems and construction of consumer facilities including power plants and transmission lines.

Activities subsequent to this full development would involve continuing operation and maintenance of the established field production system to include drilling of replacement wells as well as such additional exploration, development and marketing activities as may be justified. The schedule as projected could be accelerated or delayed.

The development effort will consist of:

a. Exploration and development drilling in the initial prospect area to compete for the current projected geothermal baseload power market of Hawaii Electric Light Company (HELCO) by 1987. If successful, a 25 MWe power plant will be constructed to convert the discovered resource to electrical power. The commercial objective of this project is to produce and sell electrical energy at a price that is competitive with electricity from oil or other alternative energy sources,

b. Additional exploration drilling to extend the areas of proven geothermal resources. (For example, it will be necessary to determine whether the resource underlying Kahauale'a, together with resources discovered and proven by other developers on the Big Island, has the potential to justify proceeding with plans for an undersea electrical power transmission cable to interconnect the islands),

c. Additional development drilling to meet additional existing or potential market demands to the 250 MWe objective of this project covered by this CDUA application.

The initial development will include the administrative processes necessary to obtain all required approvals, licenses, and permits as prerequisites for initiating drilling operations, and constructing a power plant, if appropriate.

It is estimated that twenty successful exploration wells will have to be drilled to prove that up to 250 MWe of power can be produced

from Kahauale'a. Therefore, during the initial effort, a portion of this exploration objective will be accomplished, consistent with the prospects for proceeding with the undersea cable project or such other markets as may be identified.

Commencement of project operations will involve initial access road construction (12 feet wide) to the first drilling site in the initial prospect area, a distance of approximately 9 miles generally within the proposed corridor (Figure 4) for the access road, including an off-parcel (Shipman property) access road of 1.4 miles. This access road would be improved if the initial drilling is successful.

It is estimated that full development of the geothermal resource potential of the Kahauale'a project area may require up to 35 multiple well drilling sites, assuming it is possible to conduct directional drilling of up to six wells per drilling site. Each drilling site will require 3 to 5 acres depending on the number of wells to be drilled from the site. It is estimated that up to 7 drilling sites could be occupied during the initial effort, depending on the early drilling results and the magnitude of the market that exists or can be projected. The initial drilling sites will be planned sequentially from the land area zone of "high resource potential with high volcanic hazard potential" to the land area zone of "moderate resource potential and moderate volcanic hazard potential" (see Figure 3). The drilling rig to be used is capable of drilling to a depth of 13,000 feet. The sequence of drilling is also planned on the assumption of drilling successful wells from approximately 50 percent of the planned drilling sites. The location of individual drilling sites, as currently planned, could shift due to environmental considerations

after commencement of operations, or natural disturbances such as volcanic activity.

All pipelines to transmit the geothermal fluids from the wells will be constructed adjacent to the connecting roads between well sites and power plants. These pipelines are planned to be fabricated of steel in dimensions up to 22 inches in diameter, heavily insulated, and will be mounted on steel support structures (saddles), approximately 4 to 6 feet above ground.

Power plant sites of 7 to 15 acres each are planned, depending upon plant capacity. The power plant capacities will vary from 25 MWe to 110 MWe, depending upon the characteristics of the resource and reservoir. Permits for power plant construction would be submitted if the developer obtains a contract from HELCO for a 25 MWe power plant. It is expected that the right-of-way for transmission lines to transport the electrical power from Kahauale'a to connect with main off-site distribution lines will parallel the on-site existing roads.

After an initial discovery, one or more confirmation wells will be drilled to verify the presence of a reservoir capable of economical production, to gain additional information on its dimensions and characteristics and to facilitate well testing between the wells drawing from a common reservoir. All wells will be flow tested under controlled conditions. Some venting of geothermal steam to the atmosphere will occur during the testing period.

It is planned that processed geothermal fluids which cannot be disposed of on the surface will be reinjected into a completely enclosed and sealed well bore to a depth that will ensure compliance with existing regulations. One injection well is planned for every four production wells.

Drilling operations will be conducted by the operator, True Geothermal Energy Company. The major equipments required are drilling rig, transport trailers, air compressors and drilling supplies. Approximately 40 trailer loads of equipment and supplies will be required to commence operations. The heaviest trailer load during drilling will be 40 tons. The maximum load anticipated is 100 tons during construction of a 55 MWe power plant. Loads will arrive by ship from the Mainland and will be transported to the drilling site from Hilo Harbor over a four-day period. The drilling crew will consist of 15 members from the permanent staff of True Geothermal Energy Company. Drilling and technical supervision will be provided by the operator. An on-the-job training program will be initiated upon commencement of operations to train local personnel to replace a portion of the drilling crew. It is anticipated that construction operations will be contracted for with local companies.

Traffic into Kahauale'a will be controlled by a gate at the entrance, together with such safety and security patrol activity as may be required for the drilling and construction operations within the property. After initial equipment and supplies are transported into the property, traffic will be limited to government officials and those connected with the project including drilling crew personnel, routine supply deliveries and any crews and equipment that may be required for additional road construction, site preparation, and facility construction.

Drilling operations will be conducted normally on a continuing basis until a discovery is made or the drilling rig is moved to another site.

It is estimated that each well will cost $1.7 to $2.5 million dollars which includes all labor costs, a prorated share of road construction costs, drilling pipe, cement, casing, drilling supplies and equipment operating costs. It is estimated that

8 wells will be required to supply a 25 MWe power plant. The gathering system (well head equipment, pipelines, separators) will cost approximately 20 percent of the cost of the consumer facility (power plant). A power plant of recent design is expected to cost $1,000 to $1,500 per KW (1981 dollars) of generating capacity (e.g., a 25 MWe power plant could cost between $25.0 and $37.5 million). Field maintenance operations, including reworking of wells and drilling replacement wells, are expected to cost $0.8 million per year for a production system capable of supplying a 25 MWe power plant.

Following the initial development of the 25 MWe capability, continued development drilling will be conducted to satisfy expanding market requirements (HELCO and others) and to prove the existence of such additional reserves as may be required to be "on-line" to supply a portion of the electrical power demand for an undersea transmission cable to the other islands of the State. Some additional exploratory drilling would be conducted as required by market demands or projections to demonstrate further the total production potential of the parcel. The drilling rate is projected at 6 wells per year, with an average success rate of 4 wells per year. Power plant design and construction permit applications would be submitted at a rate and capacity consistent with the resource discovery and characteristics and the market for electrical power. Up to 6 power plants may be constructed with capacities varying from 25 MWe to 110 MWe at any particular site, with the maximum estimated export production capability from Kahauale'a being 250 MWe, the scope of the project under this CDUA application.

Following the development efforts through 1995, the project activity will consist primarily of 1) development drilling to achieve the production objective of 250 MWe if not achieved earlier and 2) "in-fill" drilling and maintenance operations to achieve the estimated production potential of the Kahauale'a parcel of 250 MWe. Replacement wells as required will be drilled as step-out wells from existing production wells. Other wells may be closed temporarily for maintenance operations. Any additional construction will primarily consist of power plants to achieve the objective of producing 250 MWe. Additional exploration within the parcel would be undertaken if not previously explored, and if a market demand would justify this effort.

B. ENVIRONMENTAL CHARACTERISTICS

1. Objectives

The primary environmental objective is to assure that exploration and development of geothermal resources within Kahauale'a will not adversely affect the physical and biological environment to a significant degree.

2. Description

a. Island Wide

(1) General

The Island of Hawaii lies at the southeast end of a chain of islands extending nearly 2,000 miles across the north central Pacific. The State consists of eight major islands and 124 minor islets and atolls.

The County of Hawaii encompasses the Island of Hawaii and is the State's largest County in size with a total land area of 4,038 square miles.

The Island of Hawaii is the southern and eastern-most island of the Hawaiian Archipelago. Its principal city is Hilo which is the county seat and fourth largest city in the State.

The Island of Hawaii was formed by five volcanoes. The resulting mountains are Mauna Kea, 13,796 feet; Mauna Loa, 13,677 feet; Hualalai, 8,271 feet; Kohala, 5,480 feet; and Kilauea, 4,090 feet. Mauna Loa and Kilauea are still active volcanoes. The most recent eruptions were during September and October of 1977 and in November 1979. The 1977 eruption on Kilauea's East Rift covered an area of three square miles with approximately 45 million cubic yards of lava.

(2) Climate

The topography of Hawaii results in wide variations of climate over relatively small areas.

The climate is largely the product of the prevailing tradewinds, high mountain masses, and elevation. The annual temperature averages 75°F at sea level, but freezing weather occurs on the snowy summits of Mauna Loa and Mauna Kea where the elevations exceed 13,000 feet above sea level. The prevalence of tradewinds accounts for the high annual rainfall of 75 to nearly 300 inches on the windward side of the island. Heaviest annual rainfall occurs in the vicinity of Hilo between the 2,000 and 4,000-foot elevations where the mean annual rainfall is 275 inches a year. Areas located in the southern part of the Island receive very little rain, averaging 20 to 50 inches annually.

Temperature differences on the Island of Hawaii result chiefly from variations in elevation. The average annual temperature at Hilo is 73°F with February being the coolest month at 71°F and August the warmest at 76°F. Average daily range in temperature is between 8°F and 20°F, thus temperatures change more in the course of an average day than from season to season.

(3) Water Resources

The island's water resources are remarkably diversified. There are perennial streams and flashy streams, rain forests and manmade groundwater tunnels, cutting both into dikes high in the mountains and underground at or near sea level.

The principal source of freshwater in the island is the lens-shaped basal groundwater body, commonly called the Ghyben-Herzberg lens, which floats on denser saltwater under the islands. Average rainfall on the Island of Hawaii is about 50 inches annually and amounts to roughly 10 billion gallons of water per day.

A large fraction of the rainfall sinks into the permeable lava surface and moves down to the water table. Some groundwater is perched above sea level on ash beds or other light layers, and some is impounded in the lavas by dikes in the rift zones. The greatest groundwater reservoir is near sea level where fresh recharge from rainfall and from overflowing or leaking higher aquifers accumulates in wide spread bodies floating on the slightly heavier seawater. A part of the water perched or impounded above sea level discharges into streams and flows into the ocean, but most of the groundwater escapes at sea level as diffused flow along the shores.

b. Kahauale'a

(1) Climate

Rainfall is distributed quite uniformly throughout the year with only a 7.66 inch difference between the wettest month in December (12.33 inches) and the driest month in June (4.67 inches). Generally, the average annual precipitation for the project area is about 140 inches. Cloud cover and fog commonly occur, therefore, the climate is cool and moist most of the year.

(2) Physiography and Geology

The earliest exposed lava flow and thin intercalated ash beds of Kilauea Volcano comprise the Hilina Volcano series. These are capped by the Pahala ash which in turn is overlain by the lava and thin ash beds of the Puna Volcanic series. The lava of both series are very largely olivine basalt. The volcanoes of the Island of Hawaii are believed to have started their activity in the tertiary period.

The land of Kahauale'a is adjacent to Kilauea, the most active volcano in the world. Kilauea's two main rift zones are defined by large pit craters, cracks, and cinder cones. Lava flows, devasted areas, and steam cracks show old and new activity. The Kilauea rift zone crosses this parcel. Eruptions from Kilauea have occurred in 1963 and 1965 with lava spilling over into Kahauale'a.

The Kahauale'a Geothermal Project boundary extends from the Hawaii Volcano National Park boundary at the 3,900-foot elevation near the Thurston Lava Tube down to the 1,500-foot elevation (Figure 3).

(3) Soils

The Island of Hawaii has a wide variety of soils as a result of extremes in the factors that are active in

soil genesis: climate, vegetation, parent material, relief, drainage and time. The Soil Conservation Service fo the U. S. Department of Agriculture has classified the soil present in Kahauale'a into four different soil series and soil types. Each is defined by a unique range of values for a large number of parameters. Texture, color, structure, consistence, presence or absence of hardpan, and type of parent material are measures of the physical characteristics inherent in the soil material. Other measures, such as depth to seasonal high water table, slope, and depth to bedrock, are more a function of the soil's location rather than the material of which it is made. The dominant soil types found in the area are silt loam, loamy fine sand, muck, and stony muck.

(4) Flora

Ecotrophics is a consulting firm specializing in the performance of environmental surveys and analyses of ecosystems. It was engaged by the developer to conduct several field environmental surveys in Kahauale'a, including flora surveys.

Kahauale'a includes an array of plant communities. The major vegetation communities are the closed Metrosideros collina (J.R. & G. Forst) Gray., ('ohi'a-lehua) forest, open Metrosideros collina ('ohi'a-lehua) forest, and open scrub. Other minor vegetation communities are sporadically found throughout the major communities and include Dicranopteris lineares (uluhe) patches and Psidium cattleianum (strawberry guava) groves.

The majority of the tract is dominated with Metrosideros collina (ohia), and in places showing co-dominance with Cheirodendron trigynum (olapa), and Antidesma platyphyllum Mann., and with many smaller trees, such as the Pipturus sp. (mamaki), Broussaisia arguta Gaud. (kanawao), Pelea clusiaefolia Gray. (alani), Ilex anomala Hook & Arn.

(kawa'u), Dodonaea eriocarpa Sm. (a'ali'i), and Coprosma sp. (pilo), making up a second layer of trees. Shrubs of many genera such as Gouldia terminalis (H. & A.) Hbd. (manono), Cibotium sp. (hapuu), Cyanea, Cyrtandra, Wikstroemia (akia), Vaccinium calycenum Sm. (ohelo), Myrsine, Psychotia, Cleromontia, and Scaevola (naupaka), form a lower layer and ferns, Peperomia, and other herbs and mosses cover the ground. Ferns of a number of genera, as well as a few epiphytes, climbers, such as Freycinetia arborea Gaud. ('ie'ie), Smilax, Alyxia (maile), and lichens are found on the trunks and branches of the trees. Openings tend to be filled with Dicranopteris lineares (uluhe), and recent disturbed areas are occupied with Pluchea, Eupatorium, Galinsoga, Andropogon and other weeds and grasses.

The Metrosideros collina ('ohi'a) in the project area are affected by 'ohi'a decline. In adjacent areas, Metrosideros collina ('ohi'a) have died on thousands of acres and the specific cause and causes of the tree death is not known. Notwithstanding, some regeneration has been observed.

The first exploration by Ecotrophics into Kahauale'a penetrated a native forest in the northeast sector which contained three rare or endangered plants and an entirely new plant species. Subsequent explorations in the western and southern sectors of Kahauale'a indicated they were free of such rare, endangered and/or new species with the exception of the endemic fern Adenophorus periens which has been proposed for listing as an endangered species. From recent botanical surveys, this fern is now believed to be common and well distributed in the area.

(5) Fauna

During the period 1976-1979, the U. S. Fish and Wildlife Service conducted an extensive study of forest birds and their habitats on the land of Kahauale'a. The endangered O'u bird was found in one of the six transects.

A brief survey by Ecotrophics in September 1981 also disclosed no endangered birds. Native birds commonly found in the area are 'Apapane (Himantione sanguinea), 'Oma'o (Phaeornis obscurus), 'Elepaio (Chasiempis sandwichensis), 'Amakihi (Loxopos virens), 'I'iwi (Vestiaria coccinea) and exotic birds such as the Japanese White Eye, Cardinal Red-Billed Liothrix and others. The wide ranging Hawaiian Hawk is on the endangered list and probably exists in the area.

Ecotrophics indicated that during their field survey, one of Hawaii's only native mammal, the Hawaiian Bat, was identified in a shallow cave on open lava. Under the provisions of Public Law 93-205, Endangered Species Act of 1973, the Hawaiian Bat is classified as an Endangered Species. Little is known of its numbers, habitats, or distribution. It has been reported that bats have been seen from sea level to 13,200 feet on the Island of Hawaii but most commonly from sea level to 4,000 feet. The survey also indicated significant damage to the natural vegetation has been done by feral pigs which apparently are prevalent in Kahauale'a.

(6) Geothermally-Related Chemicals in Air, Water and Soil

Particular attention has been given to chemicals commonly found in geothermal water and steam. Ecotrophics has collected and assessed field data relative to mercury aerometry, fixed gas aerometry, soil chemistry - mercury, arsenic, soil chemistry - pH measurements, and leaf tissue analysis for mercury and other chemicals in the project area.

These data were collected to provide environmental baseline reference so that any future changes in the environmental as reflected in its chemistry may be identified and the direction and magnitude of such changes can be assessed.

(7) Water Quality

There are no known surface streams in this area. Drinking water in this area is normally imported or obtained by catchment rather than water wells because of the great depths for drilling and pumping.

C. ECONOMIC CHARACTERISTICS

1. Objectives

The primary economic objective is to provide a reliable and stable source of electricity for industrial, agricultural and domestic consumption in the most economical and environmentally acceptable manner.

2. Description

a. State Wide

The State of Hawaii is heavily dependent upon import fuel sources. This dependence results in a steady cash outflow to pay for energy. In 1978, over 44 million barrels of petroleum were imported into the State resulting in a cash outflow of over $600,000,000. This heavy outflow is often blamed for the depressed economic outlook.

Each island in the State independently produces its own electrical requirements. Because of this, several islands have very high electrical rates. These islands cannot take advantage of the economies of scale gained by producing larger amounts of electricity.

Both problems can be mitigated with the development of geothermal energy for the export to the other islands via submarine cables.

b. Island Wide

Tourism and sugar are the County of Hawaii's main economic sectors for revenue production. Because of external decreasing influences upon the Big Island's economy, the County is seeking various means of increasing and diversifying its economic base. New industries are constantly being sought. Of special interest to the County and private industry are

the potentials of natural energy sources which are abundant. The use of energy from these sources for industrial purposes is also being explored. Possibilities for commercial power use include mineral processing, food processing and agricultural applications. Geothermal power production on the Island of Hawaii will tend to stabilize the cost of electricity.

c. Kahauale'a

Agriculture and tourism have long been a part of the nearby Volcano-Glenwood economic life. The agriculture uses of these nearby areas include cattle ranching, ornamental plants, orchard crops, and truck crops; where the soil, rainfall and climate are more conducive to such activities. The lifestyle within these nearby areas can be described as being a rural/ agrarian community.

Kahauale'a has no economic activity at present. In the past, parts of it have been used for limited agricultural activities such as hapuu fern harvesting and ranching.

D. SOCIAL CHARACTERISTICS

1. Objectives

The social objective is to protect and enhance the social environment of the people of the State of Hawaii and in particular the people of the County of Hawaii.

2. Description

a. Island Wide

In 1980, 92,206 persons lived on the Big Island. As such, they constituted roughly 10 percent of the residents of the State. Because of the large land areas, mostly volcanic mountains, the population density of 23 persons per square mile is among the lowest in the State. Oahu, in contrast, has 1,345 persons per square mile.

Between 1930 and 1960, the population of the Big Island decreased from 73,325 to 61,332. In 1970, this population increased for

the first time since 1930 to 63,468, a small 3.4 percent increase. However, the 1970-80 decade saw an increase from 63,468 to 92,206, a 45 percent increase.

The areas of greatest growth were South Kohala, North and South Kona, South Hilo and Puna. Reasons for population growth are attributed in part to the growth of tourism, and diversified agriculture as well as stability in the sugar industry.

The 1970 census revealed the following percentage of the population by ethnic stock: Caucasians, 29; Japanese, 38; Filipino 17; Hawaiians, 12; and the rest to others. The Health Surveillance Survey of 1976 indicated that there were increases in the Caucasian, Hawaiian and Filipino groups with a decrease in the Japanese group.

In 1979, the total civilian labor force for the Big Island was 35,200 of which 2,900 persons or 8.1 percent were unemployed. The State's unemployment rate was 6.3 percent.

Labor force distribution by industry category for the Big Island in 1975 was as follows:

	No.	%
Agriculture and Forestry	2,745	11
Manufacturing	2,870	11
Transport., Comm., Utilities	1,825	7
Wholesale Trade	1,239	5
Retail Trade	4,872	19
Finance., Ins., Real Estate	1,056	4
Services	6,388	25
Local, State, Fed. Govt	4,782	18
TOTAL	25,778	100

In April 1980, the family income poverty level was set at $8,570 for a four person non-farm family. In 1975, an

Office of Economic Opportunity survey revealed that about 1 out of every 5 households on the Big Island was below the poverty level. Concurrently, in 1980, public welfare money payments totaled $15 million for 10,115 persons or roughly 11 percent of the Big Island's population.

b. Kahauale'a

Kahauale'a is situated in the Puna District. A population of 11,775 persons was living in Puna in April 1980. This was roughly 13 percent of the total population of the Big Island. Puna ranks third in district size after South Hilo and North Kona.

Within the Puna District, roughly 20 percent (2,246) of the residents were living in the three towns of Keaau, Mountain View, and Pahoa. The balance of 80 percent (9,529) were scattered throughout the district. There are several small and thinly populated communities in the Glenwood-Volcano areas north of Kahauale'a. There are no residents in Kahauale'a.

From the high of 8,284 in 1930, residents in Puna reached a low point of 5,030 in 1960. In 1970, the population increased to 5,154. The 1970-80 decade saw more than 100 percent increase from 5,154 to 11,775. The decrease is partly attributable to mechanization in the sugar industry. The large increase in the past decade is partly attributable to diversified agriculture and the emerging role of Puna as a "bedroom" community for Hilo. Kamins' estimate of 12,000 residents by 1990 has already been met in 1980. Continued growth can be anticipated if significant geothermal energy is developed in the Puna area.

In 1970 the ethnic stock for Puna residents was as follows:

Ethnic Stock	No.	%
Japanese	2,099	41
Caucasian	1,237	24
Filipino	1,152	22
Hawaiian	452	9
Chinese	85	2
Other	129	2
TOTAL	5,154	100

Because the population has more than doubled in the 1970-80 period, the above information is probably not valid. However, in line with County trends, increases will probably be seen in the Caucasian, Hawaiian and Filipino groups.

The 1975 labor force distribution by industry category and census tract provides the following for the Puna area (Census Tracts 210 and 211):

Industry	No.	%
Agriculture and Forestry	687	48
Manufacturing	352	24
Transport., Comm., Utilities	--	--
Wholesale Trade	63	4
Retail Trade	87	6
Finance, Ins., Real Estate	7	1
Services	24	2
Local, State, Fed. Govt	220	15
TOTAL	1,440	100

Compared to the County as a whole, Puna's labor force is primarily in agriculture and manufacturing. Kamins reported that for Puna the unemployment rate averaged about 10 percent during the past few years, among the highest rate in the State. If unemployment is higher, one can assume that the rate for public welfare, food stamps, unemployment compensation medicaid, etc., will be higher with possible feelings of hopelessness in attaining a good life.

Workshops have been held in Hawaii on the possible impacts of geothermal energy development. The Puna area has developed its own organizational structure through which geothermal issues can be discussed. The Puna Hui Ohana and the Leilani Community Association of Pahoa have come forth with position statements. In essence, these organizations are in favor of developing geothermal resources as long as it is "not detrimental to our peaceful and clean environment." Underlying the statements is a plea to be apprized of energy proposals so that the community can participate meaningfully in decisions.

SECTION V

IDENTIFICATION AND SUMMARY OF MAJOR IMPACTS AND ALTERNATIVES

A. TECHNICAL IMPACTS AND ALTERNATIVES

1. Impacts

a. Beneficial Impacts

Development of a significant geothermal resource in Kahauale'a would help the State of Hawaii in the attainment of its energy objectives as presented in the State Plan. The phased development of a new electrical power source for the Big Island and eventually for State-wide use would provide many economic and social benefits. The magnitude of these benefits will vary with time, generally increasing with the long-term development of the geothermal resources of Kahauale'a. Primary benefits include reduced dependence upon imported fossil fuels and stabilization of the now escalating cost of electrical energy.

b. Adverse Impacts

The development of the geothermal resources within Kahauale'a will induce various adverse impacts, depending upon the ultimate magnitude of the project and the ultimate use of the power (i.e., for export and/or local use). The Kahauale'a project area has had only limited agricultural use to date. The proposed development of an access road, well sites and power plants will disturb the existing environment. The extent of disturbance will be a function of the degree of total development, the specific development location, the nature and volume of the produced pollutants and the efforts taken to reduce these impacts.

2. Alternatives

a. No Project

The "no project" alternative would result in the continued dependence and uncertainty of supply associated with imported fuel and escalating electricity cost. Skilled job opportunities would be lost. Geothermal development and the

associated economic growth in Hawaii would remain limited. The "no project" alternative would lose the opportunity to develop one of the more promising geothermal sites in the State of Hawaii. The proximity to the geothermal source, the large size of Kahauale'a, and its location, remote for the most part from habitations, present a unique opportunity to develop a large geothermal production capability with minimal environmental impacts.

Should the geothermal resource not be available, HELCO will have to continue to expand its oil fuel generator facilities to meet its electrical requirements.

b. Other Alternatives

The tentative drilling and power plant sites associated with the project will be selected based on geophysical and geologic data, with the objective of minimal environmental disturbance. The results of exploration and confirmation drilling could change the planned multi-well development drilling pattern and power site locations. Additional road construction will depend upon the results of exploration and development activities. In all cases, actual road construction and the locating of drilling and plant sites will be preceded by a thorough ground survey. The ecological study firm of Ecotrophics has been retained by the developer to ensure that the more sensitive ecosystems in Kahauale'a are avoided.

B. ENVIRONMENTAL IMPACTS

1. Beneficial Impacts

Each stage of the geothermal development will involve careful planning to ensure the maintenance and protection of the natural resources and environment. Secondary benefits can be realized with the required access road to the proposed geothermal sites. In the event of emergencies such as volcanic eruptions, forest fires or rescue efforts, the access road could be a direct benefit in the protection and preservation of the environment and the public welfare.

There are no archaeological sites within Kahauale'a that are on the State or Federal Register. In addition, a recent literature search by a qualified archaeologist has indicated no evidence of any historic or archaeological significance associated with the project site. The relatively young age of the surface terrain in Kahauale'a has resulted from lava flows within the last 500 years which have reduced human intrusions to activities such as hapuu fern harvesting and pig hunting. A game management program will be facilitated by the opening of the access road and will be undertaken by the landowner to keep the population of feral pigs under control and thereby reduce their extensive damage to the natural vegetation of the area.

2. Adverse Impacts

Adverse impacts as a result of the geothermal development can be categorized under short-term or potential long-term adverse impacts. Short-term impacts, primarily arising from construction activities, include noise and temporary deterioration of air and visual qualities. Potential long-term impacts affecting the environment include the removal of trees during road and site construction, thereby slightly reducing the habitats of native flora and fauna. Careful planning and design will be employed to ensure minimal adverse effects.

There are inevitable air, chemical and noise pollutants associated with geothermal exploration and development. These are now well known and recognized techniques now exist to reduce them to acceptable standards.

C. ECONOMIC IMPACTS

1. Beneficial Impacts

The drilling and construction phases would provide job opportunities for individual residents and local construction firms. The increased amount of money circulating from these new activities would stimulate other areas of the economy which may result in the expansion of current positions or the establishment of new ones. Government could also benefit through the possibility of increased revenues from a stimulated economy. Economic expansion could be fostered by the development of the resource potential for producing 250 MWe through the easing of the cash outflow from the State for imported fuels. The stabilization of electrical rates will help the economy. If a submarine cable was developed to link the islands,

the rest of the State may be able to partake directly in the economic benefits of stabilized rates. If the spent geothermal fluids are utilized directly, businesses using the fluid may be able to expand their operations or new businesses may be attracted, resulting in stimulation of the economy.

2. Adverse Impacts

If significant geothermal sources are discovered and developed, the resulting economic growth and urban and rural expansion may raise the County of Hawaii's economic level, resulting in increased overall costs for goods and services.

D. SOCIAL IMPACTS

1. Beneficial Impacts

The project will create more technical and "blue collar" jobs in contrast to the service jobs in the tourism industry. These technical jobs will develop along two lines, (1) the power generating and marketing fields and (2) the development of new industries and the expansion of existing industries through the availability of stable geothermal energy resources.

The work force in the power generating and marketing fields will increase progressively as power resources are developed to meet market demands. The actual initial drilling operations will require 15 men. Initially, the drilling work force will be from the mainland. However, the length of the project, 15 to 20 years, presents an opportunity for local residents to be trained and eventually replace much of the mainland drilling crew. The developer will initiate a training program to draw local residents into the field operations. In addition, the site development will include construction of power plants and supporting facilities such as on-site roads and utilities which will create many job opportunities in the Puna area where the unemployment rate is generally among the highest in the State.

While it is intended that the first 25 MW of power will be used on the Big Island, additional geothermal power potential will

exist for development. The 250 MWe projected for the Kahauale'a area, coupled with the other geothermal activities along the east rift zone in Puna, will produce electrical power that can be exported. A 500 MWe submarine cable research project is now under way under auspices of the State Department of Planning and Economic Development, in cooperation with the University of Hawaii. The social impacts on the Big Island would be lessened if this excess power is exportable through a future submarine cable.

However, should the geothermal power be retained for use on the Big Island in line with the State's proposal to stimulate neighbor island economy, a gradually increasing social impact over a 10 to 20-year period will occur. The ultimate magnitude of the impact will depend upon the amount of prior planning. The present study effort to forecast the required infrastructure for large scale geothermal resource development is an example of the planning that can be done. Most likely, new industries will develop and result in a population expansion. The 500 MWe potential dwarfs the Big Island present electrical demand of approximately 80 MWe.

New industries will bring new wealth into the Big Island. From the State viewpoint, where $1 billion per year now flows out of the State's economy for the import of oil, what would be the benefits through use of indigenous energy resources? The benefits are mind-boggling. The availability of a stable geothermal energy resource can be the basis for proper planning and an improved social environment. The net result is an island community enjoying an improved lifestyle in pace with continual growth.

The development of dependable geothermal resources in the amounts discussed above is still 15 to 20 years away. This will permit State and local government leaders and legislators lead time to take actions as will benefit the residents of Puna, the Big Island, and the State. Conversely, the residents of Puna and the Big Island must be afforded the opportunity to meaningfully participate in the decision making processes.

As stated by Mr. Simeon Enriquez, Jr., (see Canan): "At the present time, all we have as far as jobs go is labor jobs . . . because of lack of employment a lot of young people are coming back to Puna . . . The list is 135 individuals . . . Of the 135, a very small percent are employed . . . We have a lot of qualified individuals with degrees who are cutting flowers or cutting cane or harvesting papaya . . . In the event jobs become available in the immediate Puna area we have qualified individuals to fill the positions . . . If we do not meet the qualifications, we are interested enough to go to school and train so we can fill the position. . . train us if necessary because if we the young adults of Puna and you the geothermal industry can work hand in hand together, we can benefit greatly all those that are involved."

2. Adverse Impacts

The development of geothermal resources to meet present and future demands implies continued urban and industrial growth. Rapid industrial growth will result in population growth with a need to provide the necessary infrastructure to serve the increased population.

The advent of new industries does not mean that the problem of high unemployment in Puna will be resolved. Modern chemical plants (for ethanol, fertilizer, manganese nodule processing) are not labor intensive. Rather such jobs will be highly technical resulting initially in in-migration of some new workers. However, the bulk of the work can be done by local people.

If most of the power is exported, there will be little industrial expansion on the Big Island. If large amounts of power are retained on the Big Island, industrialization will greatly increase. Any industrial development tends to impact on the value of lands, goods and services in the surrounding communities. Increases in land values will probably be accompanied by increases in lease and rental costs. Significant increases could force farmers off their farms and cause economic difficulties for poor families. In sum, any industrialization in the Puna area will cause proportionate changes in the physical environment and lifestyle of the people.

SECTION VI
PROPOSED MITIGATION MEASURES

Mitigation measures will be implemented to reduce the anticipated adverse impacts from the geothermal development. The extensive geothermal activities on the mainland and to a lesser extent in Hawaii have developed a wealth of knowledge on the potential air and noise pollutants and the most effective means of abatement or elimination. The developer will bring personnel to Kahauale'a that have experience in such operations and know how to conduct safe, clean, efficient and environmentally acceptable operations. Careful planning and orderly controlled execution is mandatory in all phases of the operation due to the high costs incurred in all phases of the development.

Environmental impacts caused by the direct effects of road, well and power plant construction will be mitigated by thorough ground surveys prior to construction. Environmental surveys of several access road corridor alternatives have been conducted by Ecotrophics. The proposed access road corridor (Figure 3) has been selected for minimal environmental impact. The initial access road will be of minimum width, without pavement and carefully laid out within the selected corridor to minimize its impact on Kahauale'a. The actual stakeout of this main access road and the interconnecting roads between drilling sites and power plant sites will follow more detailed ground surveys which will be guided by the criterion of least environmental impact. An advance ground survey will be made to assure minimum destruction of flora and fauna and avoidance of any archaeological finds and to provide maximum worker safety. Ecotrophics has already acquired extensive environmental data on the existing flora and fauna and soils of Kahauale'a and has prepared preliminary impact assessments.

Directional drilling of up to six wells from a single drilling site will minimize surface disturbance. Transmission lines for bringing power from Kahauale'a to off-site locations will be placed along existing roads where possible. On-site pipeline systems to carry geothermal fluids to the power plants will also be along existing on-site roads. Much of the proposed development will be hidden from direct observation by the forest trees that characterize Kahauale'a. The heavy rainfall (140 inches per year) promotes the rapid growth of vegetation and the "healing" of construction scars.

All construction at Kahauale'a will be in conformance with existing Federal, State and County regulations. An environmental monitoring system will be established by the developer to ensure close attention to possible pollutants and compliance with existing regulations. All operating equipment will be provided with mufflers. Well drilling will proceed with the usual drilling safeguards. Road and power plant locations will be sited to ensure continued operation in the event of volcanic activity such as lava flows. The work to date by Ecotrophics has provided baseline reference data for environmental monitoring during development of the geothermal facilities.

During drilling operations, blowout prevention equipment will be installed. All employees will be instructed in the operation of this hydraulically operated valve. Hydrogen sulfide (H_2S) detectors will be used to monitor the air. The geothermal fluid gathering system will be designed with adequate anchors and sufficient expansion joints to withstand the anticipated heat, pressures and probable earth movements. Should any rupture occur, the pipeline can be closed at the wellhead.

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